SECONDARY SCHOOL CIRCULAR No. 4. SEPTEMBER, 1918.

DEPARTMENT OF THE INTERIOR,

BUREAU OF EDUCATION,

WASHINGTON, D. C.

INDUSTRIAL ARTS IN SECONDARY SCHOOLS IN THE WAR EMERGENCY.

INTRODUCTORY.

The time has come for the Nation to make a more determined effort to secure for a larger proportion of our people a serviceable amount of technical and scientific training. Current developments are bringing to our people generally—what has long been foreseen by a few leaders—some realization of the imperative need of a supply of engineers, scientists, and skilled mechanics beyond anything this country has known.

The appeals which have been made to our higher educational institutions are producing results, but in order that these may reach their highest efficiency we must in some way stimulate the schools of secondary and elementary grade.

Much can be accomplished in this direction if we can devise some means for exerting a great driving impulse behind the movement, already under way, to vitalize the instruction in science and the industrial arts in our public schools. We must thoroughly arouse communities that are now doing little or nothing in these fields to the gravity of the situation and to the point of energetic and purposeful action, and we must encourage all those communities which are already contributing something to do more and better than ever before.

Any program that will bring this about must be formulated with due consideration for all the factors involved and for the multitudinous difficulties with which it will be beset.

In April, 1918, the Bureau of Education issued a bulletin setting forth the views of certain Government departments at Washington with reference to the schools in war time. The demand for this bulletin and for further suggestions, together with important developments that have taken place during the past few months, indicate the need for a supplementary statement which shall define somewhat

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more specifically ways and means by which the schools may contribute to the winning of the war and to the reconstruction which is to follow.

There has been an unprecedented demand in many departments of the Government service, as well as in the essential war industries, for workers of all ranks having some mechanical skill or possessing technical and scientific knowledge, capable of being put to immediate practical use. The attempt to mobilize these workers has emphasized again the meagerness of the provision which has been made in this country for producing an adequate supply of scientists and technicians, and has revealed as never before the necessity for taking effective measures to meet the situation.

CONFERENCE OF EDUCATORS.

To assist in formulating the essentials of a definite program, the Commissioner of Education summoned to Washington two groups of specialists to advise with him. A series of conferences during the week of May 20 resulted in the preparation of the following preliminary statement, including suggestions as to procedure in carrying out the recommendations. See also "Science Teaching in Secondary Schools in the War Emergency," Secondary School Circular No. 3.

The membership of the conferences called by the Commissioner of Education included:

SCIENCE.

Clarence D. Kingsley, *chairman*, supervisor of high schools, State Board of Education, Boston, Mass.
Otis W. Caldwell, director, The Lincoln School of Teachers' College, New York, N. Y.
James E. Peabody, head, department of biology, Morris High School, New York, N. Y.
George R. Twiss, high-school inspector, Ohio State University, Columbus, Ohio.
Calvin H. Andrews, principal, High School of Commerce, Worcester, Mass.
Thomas H. Briggs, professor of secondary education, Teachers' College, New York, N. Y.
Earl R. Glenn, teacher of chemistry, The Lincoln School of Teachers' College, New York, N. Y.
W. H. Timbie, head, department of physics, Wentworth Institute, Boston, Mass.
J. W. Ritchey, head, department of physics, Hughes High School, Cincinnati, Ohio.
F. F. Bunker, Bureau of Education, Washington, D. C.

INDUSTRIAL ARTS.

William T. Bawden, *chairman*, Bureau of Education, Washington, D. C.
Alfred P. Fletcher, assistant superintendent of public schools, Cleveland, Ohio.
William J. Bogan, principal, Lane Technical High School, Chicago, Ill.
Charles H. Lake, principal, East Technical High School, Cleveland, Ohio.

George F. Buxton, professor of vocational education, Indiana State University, 1117 Merchants' Bank Building, Indianapolis, Ind.
Charles A. Bennett, dean of technology, Bradley Polytechnic Institute, Peoria, Ill.
Robert W. Selvidge, professor of industrial education, Peabody College for Teachers, Nashville, Tenn.
James A. Pratt, director of shops, Williamson Free School of Mechanical Trades, Williamson, Pa.
Arthur B. Mays, head, department of industrial education, Sam Houston Normal Institute, Huntsville, Tex.
William E. Roberts, supervisor of manual training, public-school department, Cleveland, Ohio.

GENERAL STATEMENT.

The present needs of the Army and Navy for trained mechanics, and the needs of the industries behind the Army and Navy, make it imperative that high schools help in the special training of young men who are approaching military age. The War Department has sent out an urgent call for men trained in a number of mechanical trades and occupations, which for convenience may be grouped as follows:

Group.	*Foundation Work.*	*Trade Specialization.*
A. Automobile	Bench work and study of gas-engine machinery.	Gas-engine repairmen. Automobile mechanics. Tractor operators. Motor-cycle repairmen.
B. Machine work	Bench and machine work.	Machinists.
C. Metal work	Elementary sheet-metal work.	Sheet-metal workers. Pipe fitters. Plumbers.
D. Forging	Elementary forging	Blacksmiths. Wheelwrights. Horseshoers. Gas welders.
E. Electrical	Electric wiring	Electricians. Telephone repairmen. Radio operators.
F. Building	General woodworking	Carpenters. Bench woodworkers. Cabinetmakers. Cement and concrete workers.
G. Drafting	Elementary mechanical and free-hand drawing.	Machine draftsmen. Architectural draftsmen.

PRESENT SITUATION.

In this war emergency the schools are asked to give special attention to the training of automobile mechanics, since a very large proportion of the mechanical help now needed in the field is in this line.

The demand for large numbers of young people *having some practical mechanical ability* is so great that no school should hesitate to do what it can in any line of technical and mechanical instruction for which it has, or can secure, the necessary equipment and teachers.

RECOMMENDATIONS.

(1) The high schools of the country should undertake this work immediately. The type of training which fits the boy to be of most value in war emergency work furnishes him with an excellent foundation for work in industry after the war.

(2) Boards of education should make such additions to the curricula of the schools as will enable them to offer training preparatory to some of the occupations listed above. Boys who are not taking college-preparatory courses may well substitute shopwork for some of the academic subjects.

(3) Wherever practicable, cooperative shopwork (part-time division between schooling and employment) should be introduced under the direct supervision of the public school authorities.

(4) Immediate consideration should be given to lengthening the daily, weekly, and annual school sessions.

(5) Wherever practicable a number of elective two-year vocational courses should be offered, with the following division of time:

(*a*) 15 hours (60 minutes each) per week in shopwork.

(*b*) 15 hours (60 minutes each) per week in related subjects, which may include English, mathematics, free-hand drawing, mechanical drawing, science, industrial history, citizenship, physical training.

(6) For the war-training work in the general high school the minimum amount of time should be 10 hours (60 minutes each) per week, for a period of three years. This work should include: (*a*) Shopwork; (*b*) drawing; (*c*) related sciences.

(7) Those schools which have no equipment for teaching vocational subjects, but which do have available space, should use this space for shop purposes. In other cases rooms outside the school building should be rented, or a temporary building should be erected for such purposes.

(8) From 4 to 10 periods (40 to 45 minutes each) per week in the seventh and eighth grades should be devoted to handwork, with the emphasis upon practical shopwork in wood and metal preparatory to the work suggested for the high school.

(9) Consolidated and rural schools of elementary grade should be encouraged to undertake such handwork as conditions may permit, with the thought of developing skill and resourcefulness.

THE TEACHER PROBLEM.

(10) Boards of education should exercise care in the selection of shop teachers. A teacher, to be successful, should have a practical knowledge of the shopwork to be taught and experience in handling

boys. It is sometimes practicable to use the services of a skilled tradesman for part-time teaching.

(11) It should be clearly recognized that the demand by the Army and Navy and by essential war industries for workers in technical and industrial fields is so urgent that teachers of these branches may render their country the maximum measure of patriotic service by remaining in the teaching work.

PRACTICAL SUGGESTIONS FOR CARRYING OUT THE RECOMMENDATIONS OF THIS REPORT.

The pages which follow present a number of practical suggestions for carrying out the recommendations of this report, including brief outlines of selected courses of study. This material has been prepared with certain definite purposes in view, and the following general statements are offered to indicate the point of view.

GENERAL CONSIDERATIONS.

1. The primary purpose of this report, and of the resulting activity in the schools which it is hoped may be called forth, is twofold: (*a*) *To increase greatly the number of boys and young men receiving instruction in technical and industrial work;* and (*b*) *to increase the practical effectiveness of the instruction* by bringing about a more definite coordination between the work of the schools and the needs of the people, particularly in the present crisis.

2. Although the title of this report seems to limit consideration to high schools, the recommendations clearly indicate that certain phases of the work below the high school should be emphasized. If this emphasis is appropriately placed, the quickening impulse should be felt all the way down through the grades.

3. This appeal is directed toward influencing schools and cities which have thus far done nothing in the field of industrial arts, as well as those which should do more than they have in the past. Some cities have, for a variety of causes, come short of their own ideals and hopes. But whatever the record and whatever the causes, it will be a national calamity if the schools do not visualize the impending situation and do their part in meeting it.

4. The task of those who see the responsibility of the schools and who would marshal all their forces to meet the needs of the hour may be analyzed into the following elements:

(*a*) Stimulating schools and cities to expand their programs and to raise the standards of the work.

(*b*) Stimulating schools and cities that have thus far been inactive to see the importance of this work and to make adequate beginnings.

(*c*) Stimulating boys and girls in increasing numbers to avail themselves of opportunities that may be provided.

(*d*) Creating public sentiment that will support the measures proposed by the schools and make the necessary funds available.

(*e*) Making some constructive contribution toward the problem of securing the necessary teachers.

(*f*) Furnishing additional information, advice, and suggestions as to procedure whenever needed.

5. Although the appeal is urgent, there are practical difficulties in the way of a concerted response which must be faced. It would be futile, as well as foolish, to issue instructions which would result in a stampede for results which are not procurable. For example, the conditions in the market for machine tools of the kinds required for certain lines of work outlined herein are such that there is practically no supply available for school use. Of many items there is only a limited supply, and the distribution of these is a serious transportation problem.

6. The first and main reliance, therefore, must be on larger enrollments, more intensive methods, and more efficient activity in schools already provided with suitable equipment. If new equipment is to be acquired, schools should limit themselves so far as possible to what is available and near at hand, and proceed with caution in entering the mechanical equipment market.

7. In considering the qualifications of the teachers who are to carry out the suggestions of this report, it is important to observe the emphasis placed on practical experience and knowledge of the occupation for which the students are preparing. At the same time it should not be overlooked that this is *a teaching job*. Superintendents may well take warning from abundant experience of the difficulties involved in employing mechanics directly from the industries as teachers, without professional preparation or teaching experience, except under skilled supervision and direction. There is a technic in teaching, just as there is a technic in a skilled trade, and the possession of one is no indication or guaranty of the possession of the other.

8. Details of equipment, courses of study, and methods of instruction are omitted for the most part. The material presented indicates in general terms the results sought, leaving to properly qualified directors and teachers the task of selecting those portions applicable in any given school, and of making the necessary adjustments to conditions as they exist. It can not be too strongly emphasized that this report is not an attempt to indicate a method by which the schools can dispense with skilled teachers and directors of this work.

9. There is the "exercise" method of shop instruction and the "factory" method, and there is middle ground between the two.

Exclusive employment of the exercise method is wasteful of material, and exclusive employment of factory methods does not conserve the interests of the student. The efficient teacher adopts an eclectic method and keeps the instructional ideal constantly in view. It frequently happens that articles which are needed for immediate service do not contain the best distribution of processes for instructional purposes. On the other hand, many projects designed primarily so as to involve the desired processes in the making do not find any important use. There must usually be a compromise.

10. The purpose of the instruction is to make a definite and substantial contribution toward increasing the available supply of skilled mechanics in whatever line the school possesses or can procure the requisite facilities, but especially in those trades called for by the Army. No school should fail to do what it can simply because it can not do the complete job and turn out finished journeymen workers. The "foundational work" fundamental to a group of trades is just as important, when efficiently done, as the more specialized trade instruction which comes later. The former can be done in the general high school, in the junior high school, and in the upper grades of the elementary school, when facilities for the more specialized trade work are out of the question.

The point is that any school having any kind or amount of technical equipment should use it to the utmost in this emergency, and carry its students as far as possible toward the goal of preparation for definite service; and schools which now have no facilities for this work should not delay remedying this lack of what now appears to be an essential feature of the modern school system.

COURSES OF STUDY.

The following outlines are based on the analysis of war emergency needs as given on page 3, under "General statement."

GROUP A. AUTOMOBILE.

Qualifications for admission.

(1) Minimum age, 14 years.

(2) Minimum preparation, completion of the sixth grade; ability to do the work.

(3) Maximum size of class, 16.

Limitations of time.

(1) Total number of hours recommended:

Machine shop instruction for foundation work, 150 hours.
Electrical instruction for foundation work, 150 hours.
Shop and class work in specialized trade course, 300 hours.

(2) Minimum length of class session, 90 minutes.

(3) Number of class sessions per week, 5.

(4) By the adoption of a cooperative plan nearly all of the practical work of the course may be given in a gas-engine repair shop. The school should give the classroom instruction.

Equipment.

(1) Minimum: Several automobile chassis complete, with engine (one for each 10 students); one or two engine lathes, drill press, arbor press, tool grinder, with necessary equipment; vulcanizing outfit; chain hoist; necessary hand tools.

(2) Supplementary: Desirable supplementary equipment includes additional types of gas engines; special types of carburetors, starting units, etc.; gas welding outfit; additional machine-shop equipment.

Qualifications of teachers.

(1) Essential: Should have had several years of practical trade-experience, such as automobile assembly plant foreman, service-station foreman, general auto mechanic, engine-repair man, general machinist, foreman of gas-engine factory.

(2) Desirable: Technical training; professional training; ability and experience in training boys and men.

FOUNDATION WORK.

The course should cover all of the repair work that is done in the ordinary garage, including vulcanizing tires, grinding valves, removing carbon, adjusting bearings, replacing worn or broken parts, up to and including the complete take-down and assembly of a car.

Elementary machine-shop practice.

(1) Bench work: Chipping and filing to size, straight, square; hand lathe and bench lathe for fitting parts; assembling special machines and babbitting; assembling gas engines.

(2) Lathe work: Care of machine, grinding tools, centering work; plain cylindrical turning to size between centers; turning tapers between centers, by taper attachment, by compound rest; turning metal for running, for force, for shrink size fits; calculating simple gear ratios for thread cutting.

(3) Chuck work: Centering work in independent chucks; boring to size and straight, using calipers and gauge; boring tapers by taper attachment and compound rest; cross facing, drilling, and boring, internal threads of all kinds; use of boring bar and cutter bar; pump and engine cylinder boring.

(4) Drilling: Placing and clamping; laying out and drilling holes in steel, cast iron, brass, and aluminum; grinding drills; reaming; use of ratchet drill and "old man"; chain drills and portable electric or pneumatic drills.

Elementary electricity and magnetism.

(1) Theory: The electric current; electrical terms and units; resistance; circuits, series and divided; the Wheatstone bridge; primary cells, magnetism, electromagnetism, electromagnetic induction; electrical instruments; storage battery; automobile wiring; testing; the magneto—high tension, low tension; the generator; commutator; testing, repairing; electric motor, testing, repairing; automobile ignition; starting and lighting apparatus; specialized study of electrical apparatus used on the auto.

(2) Shop practice: Wiring, laying out and testing; use and care of instruments; winding coils and armatures; repairing motors, generators, magnetos, induction coils, switches; soldering and taping joints; special practice in form coil winding for various purposes; making cores for magnets; assembling armature cores and commutators; testing commutators for shorts and grounds; making complete induction coil for ignition.

SPECIALIZED TRADE COURSE.

General study of the automobile.

(1) The engine: Types, crank shaft, connecting rods, pistons and rings, bearings, cam shaft, valves, and push rods, oiling system; cooling system; muffler.

(2) The carburetor: Types, gasoline, tests, mixture, heaters.

(3) The ignition coils, magneto and battery systems, spark plugs, induction coils, distributors, condensers, faults, repairs.

(4) The cooling system: Types, radiators, pumps, fans, freezing, testing and adjusting.

(5) Starting and lighting system: Starting motors, charging generators, regulation and control, location on car, measuring instruments, testing and repairing.

(6) Clutch: Types, care and adjustment.

(7) Universal joint: Types, protection.

(8) Transmission: Discussion of purpose and principle of operation; comparison of types; installing and suspending.

(9) Rear axle and differential.

(10) Wheels: Front axle, brakes, steering gear, springs.

(11) Frame, bearings.

(12) Tires, driving.

Study of internal-combustion engines.

(1) The engine.
   - a. The cylinder: Grinding, reaming, lapping, welding, removing carbon.
   - b. Pistons: Lubrication, rings, wrist pins.
   - c. Connecting rods: Lubrication, bearings, balancing connecting rods and pistons.
   - d. Crank shaft: Design, repairs (straightening, welding, truing up), bearings (alignment and balance).
   - e. Cam shaft: Design, valve gear, valve grinding, scraping, timing engine.

(2) The cooling system.
   - a. Kinds: Air, water.
   - b. Defects: Freezing, leakage.
   - c. Radiator design: Auto, stationary.

(3) Lubricating systems.
   - a. Kinds: Force feed, gravity, splash.
   - b. Choice.
   - c. Repairs.

(4) Fuels.
   - a. Kinds: Gasoline, kerosene, alcohol, distillate, heavy oil.
   - b. Characteristics.
   - c. Mixing devices: Carburetor, mixing valve, sprayer.

(5) Ignition systems.
   - a. Make and break: Generator, battery.
   - b. Jump spark: Magneto, high and low tension.
   - c. Starting and lighting systems.

Trade processes that should be covered.

(1) Essential: Removing and replacing tires; cleaning spark plugs; patching and vulcanizing tubes and casings; removing carbon; grinding valves; valve timing and adjusting; complete lubrication of the car; taking apart and assembling carburetors; adjusting carburetors; taking apart and assembling clutches, transmissions, and gear sets; taking apart and assembling rear axle; taking apart and assembling steering gears; alignment of wheels; methods of locating trouble; setting a magneto; complete takedown and assembly of automobile engine.

(2) Supplementary: Supplementary trade processes might include: Taking out and replacing a wiring system; taking down and assembling the starting unit; making in the machine shop the simpler parts which need replacement; welding cracked cylinders; welding, straightening, and truing crank shaft.

Suggested projects.

The projects to be undertaken are indicated in the outline above.

Nature of work in related subjects.

(1) Drawing: Sketches of all kinds of automobile parts, showing the construction of the various parts and the function of each as a part of the automobile; simple projection; free-hand shop sketching; necessary conventions; reading blue prints.

(2) Science: Study of heat, expansion, pressure, inertia, atmospheric pressure, lubrication, etc.; gasoline and other fuels; vacuum, gravity, and pressure supply systems; friction; operation of starting units; electrical devices; cycles as applied to multicylinder motors; comparison of various types of ignition and starting systems, etc. Also related elementary chemistry.

GROUP B. MACHINE WORK.

Qualifications for admission.

(1) Minimum age, for the foundation work, 14 years.

(2) Minimum preparation, for the foundation work, students should be physically able to perform the ordinary operations of the machine shop and should be able to perform reasonably well the fundamental operations in arithmetic. Preferably they should be in the first year of the four-year high-school course or in the last year of the junior high school, though academic advancement should not be the sole determining factor. It will help if good manual-arts instruction has been offered in previous years.

For the specialized trade courses the minimum age at entrance should be one year older, and the students should be correspondingly further developed.

(3) Maximum size of class, 20.

Limitations of time.

(1) Total number of hours recommended:

Shop instruction, foundation work, 180 to 270 hours, with additional time for related work in science and drawing.

Shop instruction, specialize trade course, 540 to 1,080 hours, with additional time for related work in science and drawing.

(2) Minimum length of class session, 90 minutes.

(3) Number of class sessions per week, 5.

(4) Wherever possible cooperative arrangements should be made with industrial plants for a half-time plan of division between school and employment. The alternate-weeks plan has been found practicable.

Equipment.

In general, the same equipment should be provided for the foundation work as for the machinist-trade course.

(1) Minimum: Equipment for a class of 16 may include the following:

Lathe, 14 inches (2 to 4).	Shaper.
Lathe, 16 inches.	Power hack saw.
Lathe, 18 inches or larger (1 or 2).	Grinding machine.
Milling machine.	Wet tool grinder.
Drill.	Speed lathe.
Sensitive drill.	Bench, with 6 vises.

In addition, there should be a proper assortment of lathe tools, milling cutters, drills, reamers, mandrels, calipers, gauges, wrenches, and miscellaneous small tools.

(2) Supplementary: Larger number of lathes, boring mill, gas forge.

Qualifications of teachers.

(1) Essential: Practical experience as a machinist, resulting in extended knowledge of the trade, its tools and processes, shop kinks, shop routine, labor and living conditions; ability to use tools properly and to get work out with dispatch.

(2) Desirable: Knowledge of principles of teaching with related information regarding boy activities and interests; ability to teach, including power to analyze subject matter, to organize a day's teaching plan, to give instruction with clearness and force, to manage the class period successfully and to control discipline; such personal qualities as enthusiasm, affability, integrity, and good presence.

FOUNDATION WORK.

Range of topics.

The student should be given an acquaintance with a wide field of information relating to the industry.

Topics for lectures and demonstrations should cover iron and steel and other materials used in the machine trades; description of the nature of fundamental processes; standards of workmanship; kinds and makes of tools; study of the factory or shop in which the work is most typical; the work and life of the machinist; and a comparative study of several related occupations.

Trade processes that should be covered.

It is important that the student get some practice on each of the common machines. *Lathe:* Cylindrical turning, taper turning, thread cutting, faceplate turning, chuck work. *Planer:* Vertical and horizontal cutting of rectangular blocks, clamping to avoid spring, angular work. *Shaper and milling machine:*

Cutting plane surfaces at right angles, surface and down cutting, angular work, hexagonal work, cylindrical work on centers, slab and end millwork, indexing, gang milling. Exercises in drilling, cylindrical grinding, chipping, and filing.

SPECIALIZED TRADE COURSE.

Range of topics.

The nature of the work demanded to meet war conditions should be made clear. Emphasis should be given to important phases of the machine trades, their relation to the manufacture of munitions and other war products, and to transportation, maintenance, field repairs, etc.

Trade processes that should be covered.

Emphasis should be given to practical work involving speed and repetition, and to planning and routing work so as to secure the maximum service from given equipment. Processes taught should cover as much as practicable of the work of the skilled mechanic in the machine industries, including thread cutting, external and internal; straight and taper threads; tapering and fitting; hand turning in brass; surfacing, slotting, facing, undercutting; cutting spur, bevel, spiral, and worm gears and racks; spiral milling.

Suggested projects.

Shop projects should follow as closely as possible the requirements of war needs and of the important industries, while keeping constantly in view the primary aim and purpose of *instruction*. The important thing is to gain ability to turn out good work quickly, rather than to emphasize the making of particular products.

Wherever the making of a quantity of special articles contributes to the progress of the students, such work should be given a place. In the school shop, however, the turning out of a manufactured product should not be permitted to jeopardize or delay the acquisition by the students of the knowledge and skill for which the school shop exists.

New tools for any school shop, scientific apparatus, and home machines and devices are suggested. Parts of machines may be made, such as vises, lathes, gas engines, electric motors, vacuum cleaners; small tools and supplies, such as wrenches, bolts, etc.

Nature of work in related subjects.

(1) Drawing: Free-hand shop sketching; lettering; making tracings and blue prints; reading working drawings; machine drafting, details, assembly; elementary machine design.

(2) Science: Physics, chemistry; topics relating to the production of iron and steel; composition and qualities of mild steel, tool steel, etc.

(3) Mathematics: Sufficient instruction for handling necessary computations, formulas, etc.

GROUP C. METAL WORK.

Qualifications for admission.

(1) Minimum age, for foundation work, 12 years; for the trade courses, 14 years. Minimum preparation: Pupils should not begin the foundation work earlier than the latter half of the seventh grade nor the trade courses earlier than the ninth grade.

Older pupils, who have evident ability to do the work, but who have not the academic qualifications indicated, may be allowed to take the work.

(2) Maximum size of class, for foundation work, 24 (preferably 18); for trade courses, 20 (preferably 15).

Limitations of time.

(1) Total number of hours recommended:

Shop instruction, for foundation work, 90 hours, exclusive of related work in science and drawing.

Shop instruction, for specialized trade courses, 180 hours, exclusive of related work in science and drawing.

(2) Minimum length of class session, 90 minutes.

(3) Number of class sessions per week, 5.

Equipment.

(1) For foundation work, should include: Hand machines for squaring, folding, forming, grooving, turning, wiring, burring, setting down, and beading. A small cornice brake is desirable. A dozen or more assorted stakes, one or more bench plates, six gas furnaces (or charcoal pots or gasoline torches, if furnaces are not available), assorted hand tools varying in number from one to the size of the class, pipe vise, pipe cutter, stock and dies.

(2) For sheet-metal trade course, should include: Hand machines for squaring, folding, forming, grooving, turning, wiring, burring, setting down, and beading, and cornice brake. A complete assortment of stakes, necessary bench plates, furnaces, and assorted hand tools in numbers sufficient for the efficient conduct of classes.

(3) For plumbing and pipe-fitting trade course, should include: Vise benches equipped with pipe and machinist's vises, gas pliers, pocket pliers, screw drivers, files, hack saws, plumber's hammers, monkey wrenches, calking tools, cold chisels, pipe wrenches, pipe cutters, ratchet reamers, chain tongs, stock and dies, plumber's furnaces. Traps and bowls for demonstrating syphonic action. An assortment of shut-off and safety valves for demonstration purposes.

Qualifications of the teacher.

(1) For foundation work: Two types of teacher represent essentials for conducting classes in the foundation work outlined: *First*, a trained teacher in sheet-metal and general metal work, from an accredited school for industrial teachers. *Second*, an intelligent craftsman in the sheet-metal industry who gives evidence of teaching power. A teacher combining the qualities of both of these types is desirable.

(2) For the trade course preparatory to sheet-metal work: The teacher should be an experienced craftsman, with teaching experience if possible, but at least with evidence of teaching power.

(3) For the trade course preparatory to plumbing and pipe fitting: The teacher should be an experienced craftsman, with teaching experience if possible, but at least with evidence of teaching power.

FOUNDATION WORK.

The foundation work may begin in any grade, succeeding the first half of the seventh, included in the junior high, general high, or technical high schools.

Processes that should be covered.

The fundamental processes of the sheet-metal trade, such as the use of measuring tools in laying out simple and more or less intricate patterns, handwork in setting, forming, soldering, seaming, grooving, punching, riveting, setting down, swaging, chiseling, and the use of machines in folding, forming, wiring, punching, burring, setting down, seaming, beading, grooving, drilling, and soldering.

Simple problems in pipe fitting, involving cutting and the use of stock and dies, should be included in this fundamental work.

Suggested projects.

So far as problems of expense and materials permit, the processes indicated above should be involved in the construction of finished products of personal or civic value, rather than in projects designed to present exercises.

Simple kitchen utensils serve the purpose, such as cutters, boxes of various types, measures, scoops, funnel, cups, dippers, pans, dustpan. Projects of more general use, such as pails, garbage can, ash can, waste can, coal bucket, sprinkling can, tool box, etc. Simple building problems such as gutter work and pipe work, involving elbows and tees.

Nature of work in related subjects.

(1) Drawing: The drawing of sheet-metal work is primarily the development of surfaces, which depends upon a knowledge of projections. A preliminary course in simple working drawing involving the principles of projection is desirable, followed by the principles of developments applied in the shop projects.

(2) Science: Sheet-metal work may be closely related to science in the study of heat, fluxes, effect of acids, solder, and other alloys, tinning and galvanizing, and the manufacture of sheet iron and tin plate. The elementary treatment of certain topics in physics and chemistry will provide the instruction needed.

(3) Mathematics: Certain topics in algebra, geometry, and trigonometry, especially as related to projection drawing.

SPECIALIZED TRADE COURSES.

These may include two types of courses: (1) Preparatory to sheet-metal working, and (2) preparatory to plumbing and pipe fitting.

SHEET-METAL WORKING.

Training for sheet-metal workers may begin in the ninth grade or in any grade above the ninth, in junior high, general high, or technical high school.

Processes that should be covered.

The work should cover the fundamental processes of the sheet-metal trade, such as the use of measuring tools in laying out simple and more or less intricate patterns, handwork in setting, forming, soldering, seaming, grooving, punching, riveting, setting down, swaging, chiseling, and the use of machines

in folding, forming, wiring, punching, burring, setting down, seaming, beading, grooving, drilling, and use of the cornice brake.

Suggested projects.

Shopwork covering principles and processes indicated above, set forth in projects produced on the commercial or quantity basis. Shop and field projects in building construction. Roof work, including flashings, valleys, ridge and hip rolls, gutters and spouts, cornice work. Interior work, such as heating and ventilating ducts, fire coverings, drying systems, etc.

Nature of work in related subjects.

Further study of the principles suggested under "Foundation work," above, and particularly their application in practical problems, including projects to be worked out in shop or field practice.

PLUMBING AND PIPE FITTING.

A course preparatory to service as plumbers and pipe fitters, based on "foundation work" in elementary sheet-metal work, outlined above. Instruction may begin in the ninth or any subsequent grade in junior high, general high, or technical high school.

Processes that should be covered.

The course should cover the principles of plumbing and pipe fitting, applied to practical work in the installation of modern plumbing and heating systems.

Suggested projects.

Work should be done in a model building, or sections of building, where actual building conditions are not available, and should include:

(1) Roughing.—Soil pipes and connections; siphonage, testing systems.

(2) Pipe fitting.—Use of sockets, reducing sockets, socket caps, plugs, tees, cocks, flanges, unions, elbows, etc.

(3) Finishing.—Installing plumbing and heating fixtures in basements, kitchens, and bathrooms.

Nature of work in related subjects.

(1) Drawing.—A brief course in architectural drawing with emphasis upon the study and reading of architectural drawings, including standard piping plans; conventional representation; details of fitting arrangements, such as flanged and screwed work; expansion joints and bends.

(2) Science.—In connection with a study of heating, ventilating, and sanitation. Class discussions of drain construction, hot-water supply, sewage disposal, automatic flushing systems, valve construction, plumbing code, etc. Application of selected principles of chemistry and physics.

(3) Mathematics.—Elementary treatment of selected topics from algebra and geometry.

GROUP D. FORGING.

Qualifications for admission.

(1) Minimum age, for foundation work, 12 years; for trade courses, preferably 15 or 16 years.

(2) Minimum preparation, ability to do the work. Boys of 12 or 13 can make a good beginning in forging, though better work can be done by boys 14 years of age and older.

(3) Maximum size of class, 20.

Limitations of time.

(1) Total number of hours recommended:

Shop instruction, foundation work, 180 to 270 hours, with additional time for related work in science and drawing.

Shop instruction, specialized trade courses, 270 to 540 hours, varying with the trade and with the equipment available.

(2) Minimum length of class session, 90 minutes.

(3) Number of class sessions per week, 5.

Equipment.

(1) Essential: Forges, fire tools, anvils, hammers, steel squares, punches, tongs, heading tools, swages, fullers, chisels, sledges, hardies, emery grinder, etc.

(2) Supplementary: Power hammer, power hack saw, power shear, drill press, electric welding outfit, furnace for heat treatment of steel, gas furnace for high-speed steel.

(3) Wheelwrighting: In addition to the blacksmithing equipment an outfit of woodworking tools; also a few special tools, such as tenoner, tire shrinker, hooping trestle, etc.

(4) Horseshoeing: In addition to the blacksmithing equipment, files, rasps, tongs, nippers, pritchels, hoof tools, etc.

(5) Gas welding: Several oxy-acetylene outfits, with both cutting and welding torches; several preheating outfits.

Qualifications of teachers.

(1) Essential: Three years of practical trade experience and one year in a good teacher-training school.

(2) Desirable: Two or more years of training in a good teacher-training school, with particular attention to the material and methods of teaching, and additional trade experience.

FOUNDATION WORK.

The foundation work may begin in the first or second year of the junior high school; i. e., the seventh or eight school year. The trade course may begin in the second year of the regular high school or in the first year of the senior high school.

Range of topics.

The student should be given an acquaintance with a wide field of information relating to the industry. Topics for lectures and demonstrations should cover iron and steel and other materials used in the metal trades; description of the nature of fundamental processes; standards of workmanship, etc.

Trade processes that should be covered.

Building and care of fires for different classes of work; production of coke for the fire; different heats for working iron and steel; drawing and forming; bending; upsetting; welding, scarf, fork; fluxes; proper forging heat; hardening; annealing.

Suggested projects.

Meat hook, gate hook, ring, eyebolt, link, bolt, tongs, center punch, cold chisels, lathe tools, etc.

SPECIALIZED TRADE COURSE.

Range of topics.

The study of the industry should be continued and emphasis given to the place and importance of forging and gas welding in the machine trades and metal industries. Sources of supplies. Manufacture of iron and steel.

Trade processes that should be covered.

In addition to those indicated above, shouldering, fagot or pile weld, jump weld, riveting, tool making, forging high-speed steels.

Supplementary processes: Welding with electricity; welding with oxy-acetylene gas outfit; cutting with gas; use of power hammer; drop forging; heat treatment of steel in gas furnace; casehardening.

Suggested projects.

In addition to those indicated above, S hook, jaws of tongs, bolt making, angle or knee, punches, tools, taps and dies, woodworking tools.

Nature of work in related subjects.

(1) Drawing: Reading of drawings and blue prints; free-hand sketching; making simple working drawings, tracings, and blue prints.

(2) Science: Physics and chemistry; topics relating to the production of iron and steel; composition and qualities of iron, mild steel, tool steel, etc. Heat and its effects on iron and steel.

SUPPLEMENTARY NOTES.

Blacksmithing.

In foundation work in elementary forging include the usual exercises in drawing and bending, upsetting, welding, forming, and the handling of tool steel, furnishing an acquaintance with basic operations in forging, and beginning the development of skill in the use of blacksmith's tools.

For the blacksmith's trade courses it is important to furnish a good deal of practice in welding, in handling tool steel, and in hardening and annealing tool steel.

Wheelwrighting.

In the course preparatory to wheelwrighting it is desirable to furnish practice in general blacksmithing and fundamental uses of woodworking tools. In particular, practice should be furnished in filling and felloing the wheel, setting the box, and setting the tire. There should be an adequate supply of wheel parts, new wheels, old wheels, and broken parts. There should be constant practice in the repairing of old wheels of various sizes.

Horseshoeing.

In the horseshoeing course there should first be practice in welding and forming, and then as much experience as possible in the fitting of shoes.

Gas welding.

In gas welding, after a preliminary acquaintance with the welding outfit, there should be practice in both cutting and welding. Different weights and kinds of iron and steel should be used, and a large variety of both new and repair work should be undertaken. Practice in welding cast iron should be provided.

GROUP E. ELECTRICAL.

Qualifications for admission.

(1) Minimum age for foundation work, 12 years; for trade courses, preferably 14 or 15 years.

(2) Minimum preparation, ability to do the work.

(3) Maximum size of class, 20.

Limitations of time.

(1) Total number of hours recommended:

Shop instruction, foundation work, 270 to 540 hours, according to age and development of student; with additional time for related work in science and drawing.

Shop instruction, specialized-trade courses:

a. Electricians, 270 to 540 hours.

b. Telephone repairs, 50 to 100 hours.

c. Radio work, 100 to 200 hours.

d. Gas-engine ignition, etc., 60 to 90 hours.

(2) Minimum length of class session, 90 minutes.

(3) Number of class sessions per week, 5.

Equipment.

(1) Essential: Direct-current and alternating-current motors of various types; storage cells; rheostats of various types; direct-current and alternating-current wattmeters, ammeters; galvanometer; panel switchboard for operation of motor-generator sets; engine lathe, emery grinder, bench drill, bench vises, hand tools; necessary apparatus and supplies for electric wiring and installation; same, for telephony, radio work, gas-engine ignition, and auto wiring.

(2) Supplementary: Supplementary equipment would include a wider range of electrical machines, apparatus, and supplies.

Qualifications of teachers.

(1) Essential: Practical working experience in those phases of the electrical trade to be taught.

(2) Technical education along electrical lines; a degree in electrical engineering from a good four-year college course, with some attention to methods of teaching.

FOUNDATION WORK.

The foundation work may begin in the first or second year of the junior high school; i. e., the seventh or eighth school year. The trade course may begin in the second year of the regular high school or in the first year of the senior high school.

Range of topics.

The student begins with wire splicing and installation of simple bell circuits; study of various types of electric circuits; testing the effects of magnetic lines of force, magnetic field, etc.; storage batteries; annunciator, fire-alarm, and burglar-alarm circuits; house wiring; underwriters' and city code rules.

Trade processes that should be covered:

(1) Magnetism.
  a. Permanent magnets.
  b. Electromagnets.
  c. Practical application: Work out operating characteristics of many of the more common pieces of electrical apparatus.
  d. Experiments.

(2) Bells.
  a. Detailed study of all types of bells in common use.
  b. Construction of a bell of each type.

(3) Bell wiring.
  a. Installation of at least 10 of the more simple bell circuits under as near operating conditions as possible.
  b. Trouble. (Extra time and special emphasis.) Causes: In apparatus; in installation. Remedies: Repair apparatus; clear the lines.

(4) Annunciator wiring.
  a. Plain.
  b. Electrical reset.
  c. Self-set.

(5) Fire alarm.
  a. With continuous ringing bells.
  b. With master annunciator.
  c. Manually operated switches.
  d. Fusible switches.
  e. Thermostatic control.

(6) Burglar alarm.
  a. Open circuit.
  b. Closed circuit.

(7) House wiring.
  a. Code rules: National Board of Fire Underwriters; local or city code.
  b. Exposed cleat work.
  c. Concealed knob and tube work.
  d. Rigid conduit.
  e. Flexible conduit and armored cable.
  f. Mixed rigid and flexible.
  g. Wiring design from building plans.

(8) Storage battery, lead cell.
  a. Test cell for internal resistance, and effect it has on operation.
  b. Effect of charge on both terminal volts and specific gravity.
  c. Effect of discharge on terminal volts and specific gravity.
  d. Care of plates to prevent sulphation and buckling; care of electrolyte.

Suggested projects.

These are indicated in outlines of processes.

SPECIALIZED TRADE COURSES.

Range of topics.

The work begun under "Foundation work" should be continued, and the student should advance through the wiring and installation of various types of electrical appliances, including installation and maintenance of electric motors, up to the construction of simple switchboards and motors.

ELECTRICIANS.

Prerequisite.

"Foundation work," outlined above.

(1) Electrical development of heat.
  a. Test as many pieces of heating apparatus as are available, for: Working temperature, power used, commercial efficiency.
  b. Construct one or more pieces of apparatus of special design.
(2) Measurement of resistance.
  a. Drop of potential method.
  b. Comparison.
  c. Voltmeter.
  d. Wheatstone bridge.
(3) Arc light.
  a. Alternating current and direct current, operating characteristics.
  b. Study of arc lamp mechanisms.
(4) Direct current generators.
  a. Load test on series, shunt, compound.
  b. Compounding of shunt generator.
  c. Parelleling of two shunt motors.
  d. Parelleling of two compound machines.
  e. Locating and correcting trouble.
(5) Direct current motors.
  a. No-load speed test on series, shunt, compound.
  b. Load characteristics; Prony brake method.
  c. Study of direct current starting boxes.
  d. Locating and correcting trouble.
(6) General study of alternating current circuits.
  a. Inductance.
  b. Power factor.
  c. Phase relations.
  d. Condensers.
(7) Alternating current generators.
  a. Load characteristics.
  b. Paralleling; synchronizing, dark of lamp, light of lamp, synchroscope.
(8) Alternating current motors.
  a. Induction motors, single phase, polyphase.
  b. Load characteristics; Prony brake method.
  c. Synchronous motors.
(9) Transformers.
  a. Single phase, step up, step down.
  b. Two phase.
  c. Three phase.
  d. Two to three phase, and vice versa.
(10) General study of alternating current and direct current switchboards.
(11) Direct current armature winding.
  a. Lap and wave winding on dummy armature.
  b. Winding armatures.
(12) Experimental testing.

Nature of work in related subjects.

(1) Drawing: Freehand sketches of electrical joints; sketches of electrical machine parts; plotting of lines of force; sketches of simple magnet; wiring diagrams, and sketches of annunciator systems; making set of symbols for

notebooks; laying out plans for large circuits to be laid in conduit; layouts or diagrams for various lighting combinations; sketches showing wiring and methods of mounting switches, outlets, wiring control of various types of fixtures; detailed drawing of outlets, panel construction, and panel box; design of electrical system for an entire building; layouts of circuits in both two-way and three-way systems; detailed drawing of simple telephone with circuit shown; drawings of simple switchboards for single machines and parallel operation; drawing of Prony brake; wiring connection for series, shunt, and compound motors; detailed drawing of circuits; wiring diagram showing connection for reversal of rotation; detailed drawing of coil tests; detail of construction of armature coil and commutator; detail of switchboard parts; detail of wiring of switchboard; assembly drawing of switchboard; diagrams of transformers and circuits.

(2) Science: Topics such as the following should be taken up: Composition of various soldering fluxes; methods of cutting down size of wire without loss and capacity; reasons for the use of various magnetic materials; effects of magnetism on iron or steel; magnetic tempering; effect of the electric arc on metal; experiments in measurements of current; scientific study of batteries; scientific study of lighting fixtures and shades; reasons for the location of light outlets; experimental study of storage cells; study of sound and sound waves in connection with various receivers and transmitters; study of the law of conservation of energy and transformation of energy; calibration of instruments; efficiency tests with Prony brake; determination of the accuracy of overload and current limiting devices; study of resistance measurement; tests of insulation; causes and effects of metallic veins in slate and other stones; fundamental principles of alternating current, efficiency tests on transformers, and alternating current motors and generators.

TELEPHONE REPAIR MEN.

Prerequisite.

"Foundatiin work," outlined above; also topics (6) to (10), inclusive, of the courses outlined above for "Electricians."

(1) Outline of telephone system.

(2) Operation of telephone systems.

(3) Study of fundamental differences between power and telephone circuits.

(4) Study of the several currents used.

(5) Give considerable attention to study of induction, capacity, resistance, shunts, Ohm's law.

(6) Study of functions of distinctive types of apparatus; bell, receiver, transmitter, induction coil, cord circuit, repeating coils, retardation coils, resistance coils, switch hook, relays, lamps.

(7) Study and assembly of apparatus in each of six circuits. Instrument, line, cord, telephone, A and B trunk lines.

(8) Study of complete system of these six circuits, the basis of all manually operated systems.

RADIO WORK.

Prerequisite.

"Foundation work," outlined above; also topics (6) to (9), inclusive, of the course outlined above for "Electricians."

(1) Code rules governing inside installations.

(2) Construction and installation of:

a. Aerial.

b. Switchboard.

(2) Construction and installation of—Continued.
c. Tuning coil.
d. Detector.
e. Fixed and variable condenser.
f. Spark gap, rotary, quenched.
g. Transformer, open core, closed core.

GAS-ENGINE IGNITION AND AUTO WIRING.

Prerequisite.

"Foundation work" outlined above.

(1) Gas-engine ignition.
a. Make and break.
b. Jump spark.

(2) Construction and use of—
a. Low-tension magneto.
b. High-tension magneto.

(3) Automobile wiring; without grounded circuit; with grounded circuit.
a. Truck.
b. Automobile.
c. Airplane.

GROUP F. BUILDING.

Qualifications for admission.

(1) Minimum age, for foundation work, 12 years; for trade courses, preferably 14 or 15 years.

(2) Minimum preparation, completion of sixth grade; ability to do the work.

(3) Maximum size of class, for foundation work, 24; for trade courses, 20.

Limitations of time.

(1) Total number of hours recommended:
Shop instruction, foundation work, 270 to 300 hours; with additional time for related work in drawing.
Shop instruction, specialized trade courses, 270 to 540 hours.

(2) Minimum length of session, 90 minutes.

(3) Number of class sessions per week, 5.

Equipment.

(1) Minimum equipment for foundation work, for class of 24 students:

24 smooth planes (extra blades for additional classes).
8 jack planes.
16 panel saws, 8 rip and 8 crosscut.
8 tenon saws.
24 1-inch chisels (extra set for each class).
12 marking gauges.
24 try-squares.
12 hammers.
6 mallets.
6 screw drivers.
1 set auger bits.
½ dozen each ¼-inch, ⅜-inch, and ½-inch dowel bits.

(2) Equipment for cabinetmaking: Enough large workbenches to accommodate one-half the class at one time; complete set bench woodworkers' hand tools for each bench; band saw, mortising machine, boring machine, variety saw, surfacer, jointer, emery grinder; large assortment of hand screws, clamps, etc.

Desirable supplementary equipment includes: Belt sander, shaper, power grinder, veneer press, table-leg press.

(3) Equipment for cement and concrete work: Shovels, sand screen, mixing platform, measuring boxes, wheelbarrows, water barrel, buckets, floats, hoes; woodworking tools for erecting and removing forms; sledge, wrecking bar, spirit levels, etc.

Qualifications of teachers.

(1) For foundation work: The teacher should be a graduate of a good teacher-training course, with some practical experience if possible, or a graduate of a good manual-training high school, with at least a one-year teacher-training course, also with some trade experience if possible, or a man with a number of years of trade experience and one or more years in a teacher-training course.

(2) For specialized trade courses: The teacher should have at least an elementary school education, and should possess a mastery of his trade gained through successful experience as a worker in the trade. He should possess some knowledge of pedagogy and have the point of view of the teacher.

FOUNDATION WORK.

The foundation work may begin in the first or second year of the junior high school; i. e., the seventh or eighth school year. The trade courses may begin in the second year of the regular high school or in the first year of the senior high school.

Range of topics.

(1) Study of construction, care, use, sharpening, and adjustment of the common woodworking tools—planes, chisels, saws, measuring and testing tools, etc.

(2) Study of sources, structure, properties, production, milling, and grading of the woods commouly used in the building trades—yellow pine, western pine, Norway pine, white pine, hemlock, spruce, poplar, oak, ash, etc.

(3) Study of wood finishes suitable for various uses—stain, filler, primer, paint, varnish, shellac, wax, oil, etc.

(4) Study of fastenings, building hardware, etc.

(5) Elementary instruction in use and care of machinery, where power woodworking machines are available.

Trade processes that should be covered.

(1) Sharpening, adjusting, and care of tools.

(2) Making stock bills; getting out stock.

(3) Chamfering, boring, butt joiuts, scraping, sanding, finishing.

(4) Lap joints, dado joints, laying out duplicate parts, assembling.

(5) Mortise-and-tenon joints, glue joints, gluing.

Suggested projects.

The projects suggested for foundation work are examples of the work commonly used in building construction, and are selected primarily for the amount and variety of tool practice involved. Throughout this work special instruction should be given on what constitutes good construction in the various elements of a building.

(1) Part of the lock stile of a door.
   a. Sawing stock 2 inches by 5 inches by 10 inches.
   b. Plane stock square, to dimensions.
   c. Lay out and chisel mortise for meeting rail.
   d. Lay out and chisel mortise for lock.
   e. Lay out and fit hinge.

(2) Part of the window meeting rail.
   a. Plane to dimensions.
   b. Lay out and chisel tenon to fit mortise in stile.
   c. Lay out and chisel a flat bevel on long edges.

(3) Sawhorse.
   a. Saw stock.
   b. Lay out rail for leg mortises.
   c. Lay out legs, saw, and fit.
   d. Assemble and join parts.

(4) Miter box.
   a. Prepare stock.
   b. Assemble, lay out, and make cuts.

(5) Joints used in wood construction.

(6) Bench hook.

SPECIALIZED TRADE COURSES.

The student should be given a wide range of information relating to the building trades. Topics of lectures and demonstrations should include the various types of structures, sources and kinds of materials, standards of workmanship, comparative study of related occupations.

CARPENTRY.

Range of topics.

(1) Sill and floor framing; study and construction of the various types of sills; methods of fastening sills to foundations; floors, openings, bridging.

(2) Wall framing; braced and balloon frames; window and door openings; corner posts; partitions; bridging.

(3) Steel square; study of span, run, rise, pitch, foot, and face cuts of common, hip, and jack rafters; tables; board measure, brace measures, octagonal scale, and rafter table.

(4) Roof framing; cuts for common, hip, and jack rafters; construction of pitch, hip, deck, gable, and gambrel roofs; collar beams and braces.

(5) Saw filing; jointing, setting, and filing handsaws.

(6) Simple stair building; stair wells; rise and run of stringers; laying out stringers, risers, treads, winders, handrails.

(7) Inside and outside trim; laying floors, base boards, molding, casings; hanging doors and windows; cornices.

(8) Trusses, roof and bridge; king-post, queen-post, and modified forms of these; joints used for framing beams, posts, struts.

(9) Concrete form building.

Trade processes that should be covered.

So far as practicable, these processes should be carried out on actual construction work. A small building should be erected, if possible. Failing this, full-size stock should be used in constructing details or parts of a structure.

(1) Joints used in sill construction.

(2) Build section of a building, consisting of sill, corner post, floor joist, window or door opening, balloon framed.

(3) Build similar section, brace framed.

(4) Build sections of roof: Pitch, hip, hip and valley, gambrel.

(5) Set, joint, and file handsaws.

(6) Build stairs: Straight run; with winders.

(7) Build section of corner of building, including corner posts, a few adjoining studs, wall plate, hip and a few jack rafters; to be finished completely, with roof boards, shingles, sheathing, siding, and cornice.

(8) Add the inside and outside trim to project (2) and project (3).

Suggested projects.

These are indicated under "Trade processes," outlined above.

Nature of work in related subjects.

(1) Drawing: Laying out with pencil, rule, and square; simple projection; reading blue prints; free-hand dimensioned sketches of projects; architectural drafting; conventions.

(2) Mathematics directly related to the trades.

CABINETMAKING.

Trade processes that should be covered.

Use, sharpening, adjustment, and care of hand tools and power machines.
Dressing to dimension, chamfering, boring, modeling, grooving.
Joinery; butt, lap, dado, mortise-and-tenon, dovetail, and other joints.
Paneling, inlaying, veneering, gluing.
Scraping, sanding, finishing.
Furniture construction; drawer construction.

Suggested projects.

Construct selected articles of furniture and cabinetwork; taboret, center table, library table, kitchen cabinet, bookcases, writing desk, office desk, chairs, dining-room furniture, laboratory furniture.

CEMENT AND CONCRETE WORK.

Range of topics.

Uses of cement and concrete.
Sources and manufacture of cement.
Function, composition, and qualities of aggregates.
Construction of forms.
Proportioning concrete.
Mixtures.
Topping and stucco.
Reinforcing.
Concrete structures.
Waterproofing.
Decorative treatment and coloring.
Estimating.

Trade processes that should be covered.

Selecting and washing sand and gravel.
Screening.

Measuring and mixing.
Building forms.
Placing reinforcing.
Pouring.
Topping.
Applying stucco.
Floating and finishing.
Estimating.

Suggested projects.

Feed and water troughs.
Fence posts.
Pedestals.
Steps.
Walks.
Retaining walls.
Small dams.
Footings, foundations.
Part-time work, if possible, with contractor on building or other contract job.

GROUP G. DRAFTING.

Qualifications for admission.

(1) Minimum age, 12 years.
(2) Minimum preparation, completion of sixth grade.
(3) Maximum size of class, 24.

Limitations of time.

(1) Total number of hours recommended:
First course, 72 to 90 hours.
Second course, 72 to 90 hours.
Third course, 144 to 180 hours.
Fourth course, 360 hours.
(2) Minimum length of class session:
Courses one to three, 60 to 90 minutes.
Course four, 120 minutes.
(3) Number of class sessions per week:
Courses one to three, two.
Course four, five.

Equipment.

Standard school drafting-room equipment.

Qualifications of teachers.

For course one is required a skilled teacher of mechanical drafting who understands the importance and something of the methods of drafting in the principal groups of mechanical trades.

For the remaining courses there should be teachers who are experienced architectural draftsmen or experienced machine draftsmen, as well as skilled teachers.

PRELIMINARY STATEMENT.

One of the chief and most just criticisms of the teaching of mechanical drawing that has been made during the past few years is that the courses have been planned for the man who is going to be a draftsman or an engineer. This has resulted in the formulation of many courses that have forgotten the interests of the journeyman or superintendent who never expects to be a draftsman as such, but who wants to learn that part of mechanical drawing which he needs in his daily work as a journeyman or superintendent. Courses have been too comprehensive for him. Especially, they have been too inclusive in their elementary stages.

In preparing the following outlines, two things are taken for granted, namely, (*a*) that outlines in drawing are needed for students in automobile work, machine work, metal work, forging, electrical work, and building, as well as for students in drafting; (*b*) that an important purpose of the drawing work is to be of immediate practical use in the shopwork and to lead as quickly as possible to the practical drafting for the several trades.

Taking the above for granted, a large part of the usual problem work in projection, developments, intersections, and geometric constructions may be postponed until they find application in the trade drafting. If this is done, it is possible to develop the technic of practical drafting much earlier in the course than would otherwise be possible. This stimulates interest in the work and is in harmony with the consecutive short-unit idea that is becoming popular because it yields practical results from the very early stages in the drawing work. The desired results can be secured if sufficient emphasis is placed on *speed* in the execution of the work.

ARRANGEMENT OF COURSES.

With this end in view, courses have been planned, the relationship between which is indicated as follows:

Course 1.	Course 2.	Course 3.
Preliminary (for all students).	Subdividing into architectural and machine groups.	Specialized by trades or groups of trades.
One-half year, 72 to 90 hours:	One-half year, 72 to 90 hours:	One year, 144 to 180 hours:
General.....	Architectural.....	Building (woodwork). Electrical work. Metal work.
	Machine.....	Automobile work. Machine work. Forging.

The first course is preliminary, and is given to all students alike. At the end of the first half year, however, the students enter the second course, and here divide into two groups, depending upon whether the aim of the student is toward a building trade or a machine trade. These two are selected because architectural drafting and machine drafting are the two chief fields of drafting technic connected with the trades. Both of these lines of work may be taught by one teacher during the same period, but they may be taught better by special teachers in separate classes. While the student is taking these first two courses in drawing he is doing the "foundation work" in the shop.

During the second year the instruction of the third course may be given in two groups, but the problems should be selected from the trades according to the shopwork taken during that year.

Students preparing to become draftsmen begin a fourth course, a special course for draftsmen, at the middle of the second year, and spend two hours each day in drafting work.

COURSE 1.

Group I. Straight lines: The drawing of simple straight-line objects, showing two or three views, but no dimensions. Emphasis should be placed on the layout and the use of the instruments.

Group II. Circles: The drawing of two or three views of circular objects, or objects involving circles in their representation. Emphasis should be placed on the layout, use of the compass, and sectional views.

Group III. Tangents: The drawing of two or three views of objects involving tangent lines. Emphasis should be placed on accuracy of measurement and geometric construction.

Group IV. (*a*) Working drawings: The drawing of a variety of objects as they are drawn in the best drafting rooms. Emphasis should be placed on selection and arrangement of views and on dimensioning.

(*b*) Lettering: Throughout the work of the four groups mentioned above short periods of time should be set apart for instruction and practice in lettering. The vertical freehand Gothic capital letters are preferred for this course.

(*c*) Problems: There are several books on the market from which problems may be selected in following the above outline.

Throughout all this work extended practice should be given in making sketches and in reading working drawings.

COURSE 2.

SECTION A. ARCHITECTURAL.

Group I. Plan and elevations of a small building, such as a ticket house, chicken house, electric railway country station, hog house, garage, or dog house. Emphasis on the conventional methods of representing the various elements of a building, and a study of the construction.

Group II. Plan, elevations, and construction details of a summer cottage or similar building. Emphasis on details of construction.

Group III. Complete set of working plans for a bungalow or other small house. Emphasis on construction, detailing, and dimensioning.

Lettering: Throughout this course each student should be acquiring a good architectural style of lettering. Short periods of practice and instruction should be given frequently.

SECTION B. MACHINE.

Group I. Tools and gauges: Working sketches and practical working drawings of selected objects, such as simple tools and gauges. Emphasis on drafting technique.

Group II. Fastenings: Working sketches and practical working drawings of such elements as screws, bolts, nuts, etc. Emphasis on conventional methods of representation and methods of specifying sizes.

Group III. Power transmission: Working sketches and practical working drawings of collars, couplings, bearings, etc. Emphasis on standard forms and proportions.

Group IV. Machines: Full set of working drawings, including assembly drawing and details, of some small machine within the capacity of the individual student to understand. Emphasis on dimensioning.

Lettering: Throughout this course each student should be acquiring a good machine-drafting style of lettering. Short periods of practice and instruction should be given frequently.

COURSE 3.

This course should be a continuation of the second course. Essentially, it is practical drafting in the line of shopwork being pursued by the student. Incidentally, it is a time for the study of drafting elements omitted from the preliminary course. For example, students in metal work will give most of their time to developments with reference to their application in pattern cutting; students in cabinetmaking will make drawings of furniture and rods; students in electrical work will make wiring diagrams; students in automobile work will make drawings of automobile parts and study automobile mechanism.

The method of teaching should be that of assigning practical problems to individuals or groups of students, and providing the means of procuring the necessary data for their solution.

To carry out this course to the best advantage the class should be large enough to require two teachers, one an experienced architectural draftsman and teacher and the other an experienced machine draftsman.

COURSE 4.

This course is a comprehensive course for draftsmen. It should consist of two divisions: Section A for architectural draftsmen; Section B for machine draftsmen. It should include for each section all the drafting for all the trades in that section, and much theoretical and practical work besides. It should include also a reasonable amount of instruction in designing—architectural design for the architectural draftsman and machine design for the machine draftsman.

It seems unnecessary to outline this course because instructors who are competent to teach it are likely to be acquainted with the best published courses and to have additional ideas of their own.

INDUSTRIAL WORK IN CONSOLIDATED OR TOWNSHIP SCHOOLS.

Purpose.

The purpose of the instruction suggested for industrial work in centralized or township schools is to develop general hand skill and familiarity with elementary tool processes and typical materials used in constructive work. This type of training will serve as a foundation for future service in technical and industrial lines.

Scope of the work.

The work must be adapted to the age of the pupil and to conditions of the school and community.

Processes that should be covered.

Fundamental processes in construction and repair work in the use of hand woodworking and metal-working tools, in simple carpentry projects, making of concrete forms, forging, pipe fitting, and sheet-metal projects.

Special attention should be given to the care, repair, and adjustment of farm machinery of all kinds, such as gas engines, windmills, pumps, grinders, silage cutters, harvesting machines, plows, cultivators, electric-lighting units, etc.

Take up also such construction problems as the installation of a water-supply system for the farm home and other buildings; conveyor system at the barn; lighting systems; concrete work; modern problems of farm development and upkeep.

Suggested projects.

These are in part indicated above.

The projects should have to do largely with the constructions and repairs of the farm and the industries of the small community. Carpentry projects in constructions for the house, boxes, bins, troughs, hot and cold frames, coops; typical small farm outhouses; forms for concrete work; repairs on wagons, fences, and buildings; painting, glazing, etc. Forge work in construction and repair of implements and machines. Simple pipe work in the carrying of water supply. Sheet-metal work, largely soldering, in repair of utensils, ridge rolls, flashings, roofing, gutters, and spouts. Simple repairs on gasoline engines and tractors.

Equipment.

It is suggested that a room in the school building be equipped with a carpenter's bench and limited set of tools; a forge and tools; pipe vise, pipe cutter, and threading tools; simple sheet-metal hand tools, and soldering furnace; facilities for cement work; limited tools for gasoline engine and tractor work; vise, pliers, cold chisels, hammer, screw driver, wrenches, files, etc.

The teacher.

In many centralized schools provision is made for a teacher of industrial work. In others arrangements might be made for part time work between two or more such schools. A teacher with general industrial training should be competent to direct individual activities in the types of work mentioned. Local craftsmen may be appealed to for special help and advice. Special teachers and industrial specialists from city schools and manufacturing plants might also be induced to give special talks and demonstrations.

INDUSTRIAL WORK IN RURAL SCHOOLS.

Purpose.

The purpose of the instruction suggested for industrial work in rural schools is to develop general hand skill and familiarity with elementary tool processes and typical materials used in constructive work. This type of training will serve as a foundation for future service in technical and industrial lines.

Scope of the work.

The work must be adapted to the age of the pupil and to conditions of the school and community.

Processes that should be covered.

Processes involved in simple construction and repairs.

Suggested projects.

Simple projects for use on the farm and in the home, such as boxes, harness racks, seed tester, chicken coop, chicken feeder, milking stool, trough, forms for concrete work, bird house, rough toys, kitchen utensils, etc. Painting fences and outhouses, setting glass and other repairs about the farm or schoolhouse.

Equipment.

It is suggested that the schoolhouse be provided with a carpenter's bench and a few woodworking tools—rule, try-square, crosscut saw, ripsaw, jack plane, hammer, drawknife, hand ax, brace and a few bits, putty knife, paint brushes, etc.

The teacher.

It is realized that under the conditions of the rural school few, if any, teachers will have experience in industrial work. Problems can be discussed with the children and encouragement given for initiative in meeting these problems. Several manuals giving directions in handwork problems for the farm will be suggestive and instructive. Appeals may be made for suggestions and advice to local carpenters or other available tradesmen. Arrangement might be made for an occasional hour of instruction from such workmen.

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